REMARKS

Claims 1 through 64 are pending in the instant patent application. Claims 1, 10, 11, 21 through 29, 31, 50, 55, 56, and 59 through 64 are the independent claims. Claims 2 through 9 depend from Claim 1. Claims 12 through 20 depend from independent Claim 11. Claim 30 depends from Claim 29. Claims 32 through 49 depend from Claim 31. Claims 51 through 54 depend from Claim 50. Claims 57 and 58 depend from Claim 56.

Applicants express appreciation of the indication that Claims 23 through 24 are allowed.

Applicants also note that Claims 6, 16, and 22 are indicated to include allowable subject matter, but stand rejected under 35 U.S.C. § 112. Applicants thank the Office for the indication of allowable subject matter of Claims 6, 16, and 22.

Consistent with 37 C.F.R. § 10.23(c)(7), Applicants are providing information to the Office identifying a patent application of another from which Applicant has copied claims. Applicants' new Claims 31 through 59 are added to the instant patent application, and were copied from pending Claims 31 through 59 of United States Patent Application Serial No. 10/842,157 to Sayyar-Rodsari *et al.*, (hereinafter "Sayyar-Rodsari"). To date, these claims have not been allowed, or examined, and are pending.

This Sayyar-Rodsari application is currently being examined by Examiner Gami Tejal of the Office in Group Art Unit No. 2121 of Class/Subclass 700/029. Applicants have added new Claims 60 through 64, which are directed to the same or substantially the same subject matter as independent Claims 31, 50, 55, 56, and 64 of the Sayyar-Rodsari patent application as discussed more fully below. Applicants will note the support for each claim in the instant Amendment.

1. Rejections under 35 U.S.C. § 112, first paragraph

In the Action, Claims 1 through 22, and 25 are rejected under 35 U.S.C. § 112, first paragraph because the specification, while enabling for a polymer process controller and a financial controller, arguably does not provide enablement for other applications. The Office alleges that the specification does not provide enablement to use the invention commensurate with the scope of the claims.

Applicants respectfully disagree with the Office, since the independent claims are directed to a computer implemented method for modeling a non-linear empirical process. The computer implemented method provides for a constrained model that enables precision control of the non-linear empirical process. Clearly, the specification and the claims provide support for such a computer implemented method. One of ordinary skill in the art would be able to use the teachings of the specification to implement the computer related method in a number of situations for a constrained model that enables precision control of the non-linear empirical process. These include applications, such as, for example, an online or offline environment, forecasting, pattern recognition, modeling, batch process modeling, or the like. Applicants are in no way limited to a financial controller, or a polymer process controller, or any other specific applications, and these are merely illustrative.

Under M.P.E.P.§ 2161.01, when basing a rejection on the failure of the Applicants' disclosure to meet the enablement provisions of the first paragraph of 35 U.S.C. §112, the Office must establish on the record a reasonable basis for questioning the adequacy of the disclosure to enable a person of ordinary skill in the art to make and use the claimed invention without resorting to undue experimentation. See *In re Brown*, 477 F.2d 946, 177 USPQ 691 (CCPA 1973); See also *In re Ghiron*, 442 F.2d 985, 169 USPQ 723 (CCPA 1971). Once the Office has advanced a reasonable basis for questioning the adequacy of the disclosure, it becomes incumbent on the Applicants to rebut that challenge and factually demonstrate that his or her application disclosure is, in fact, sufficient. See *In re Doyle*, 482 F.2d 1385, 1392, 179 USPQ 227, 232 (CCPA 1973); See also *In re Scarbrough*, 500 F.2d 560, 566, 182 USPQ 298, 302 (CCPA 1974); See also *In re Ghiron, supra.* See MPEP § 2106(V)(B)2 and § 2164 through § 2164.08(c).

Applicants contend that no such reasonable basis has been made, or put forth by the Office. Moreover, Applicants have provided numerous block diagrams, and mathematical proofs to illustrate the computer implemented method, and have explained the block diagrams to illustrate the present invention. One of ordinary skill in the art could implement the present computer based method in any number of applications involving modeling a non-linear empirical process, which is, in fact, currently believed to be implemented in practice. Moreover, Applicants provide even additional support in the specification of examples of specific sources

that can be used in connection with the elements, such as, the optimizer, and other components without undue experimentation.

Applicants contend that the specification discloses in great detail (1) Jacobian derivative calculations, (2) Hessian derivative calculations, and (3) model predictions, and one of ordinary skill in the art would be able to incorporate these derivatives and model error into a controller or optimizer for a wide range of applications as is known in the art for predictive devices. These include such as, for example a batch controller, a financial controller, an aviation controller or any other computing device that can use the disclosed and claimed invention. The instant application is enabling as it discloses in detail (1) Jacobian derivative calculations, (2) Hessian derivative calculations, and (3) model predictions/error, and, thus, can be used in any application that receives the same. Reconsideration and withdrawal of the rejection are respectfully requested.

2. Rejections under 35 U.S.C. § 112, second paragraph

In the Action, Claims 1-9, 11-19, 21, and 25 are rejected under 35 U.S.C. § 112, second paragraph as being allegedly "incomplete" for omitting essential steps, such as an omission amounting to a gap between steps, citing M.P.E.P.§ 2172.01. The Office alleges that a step that explains how a constrained model provides precision control in the absence of a controller is omitted.

In response, Applicants have amended independent Claims 1, 11, 21, and 25 to recite that the constrained model enables precision control of the non-linear empirical process, instead of providing precision control of the non-linear empirical process. Applicants submit that the claims are directed to a computer-implemented method for modeling a non-linear empirical process, and do not omit any essential steps. The method provides for enabling precise control of a process. The method provides for an analytically constrained model with global behavior. The analytically constrained model is valuable and provides the ability to predict global behavior of the non-linear empirical process. Reconsideration and withdrawal of the rejection of Claims 1-9, 11-19, 21, and 25 are respectfully requested.

Applicants herein amend Claim 10 to render the claim in independent form. Claim 10 was originally presented as a dependent claim depending from independent Claim 1. Support for the amendment can be found in the patent application as originally filed, for example, at page 17, lines 21-30 of the application. Independent Claim 10 is directed to modeling a non-linear empirical process, and also controlling a greater process. Independent Claim 10 recites that the method includes a controller to control the greater process. Amended Claim 10 more particularly points out and distinctly claims the subject matter, which the Applicants regard as the invention. Applicants respectfully submit that the claims are clear, definite, and conform to 35 U.S.C. § 112, second paragraph. Reconsideration and withdrawal of the rejection are respectfully requested.

3. Rejections under 35 U.S.C. § 101

In the Action, Claims 1 through 22, and 25 are also rejected under 35 U.S.C. § 101. The claims are rejected since the invention is supposedly directed to a mere abstract idea. Applicants must respectfully disagree. Applicants note that a previous rejection under 35 U.S.C. §101 was made in an Office Action dated August, 2005, and this rejection was already successfully traversed by the Applicants.

Applicants' claims not only require determining an instruction plan for modeling a non-linear empirical process but also for storing the result of execution of that instruction plan, or an analytically constrained model. These steps are clearly described in the preamble as a computer implemented method.

The model is constrained to provide for predictions of global behavior and this prediction of global behavior is a useful, tangible and concrete result. Moreover, this is useful, tangible, and provides for a computer implemented method that can be used in regions of sparse initial input or in regions of missing initial input. The claimed computer-implemented method for modeling a non-linear empirical process includes creating an initial model generally corresponding to the non-linear empirical process to be modeled with the initial model having a base non-linear function, an initial input, and an initial output.

The computer-implemented method includes constructing a non-linear network model based on the initial model. The non-linear network model has (a) multiple inputs based on the initial input, and (b) a global behavior for the non-linear network model as a whole that conforms generally to the initial output.

In addition, this constrained non-linear model provides reliable predictive global behavior in regions of missing or sparse input data, which the prior art does not. Thus, not only does the invention provide a concrete and tangible result, it also provides an advantage over other ways of modeling behavior. This additional advantage is over the prior art neural networks, which react poorly in regions of sparse input, deficiencies acknowledged by the cited references themselves. See Klimasauskas at Column 2, lines 27-47. This benefit provides an additional concrete and tangible result, which is not disclosed in the prior art. Reconsideration and withdrawal of the 35 U.S.C.§ 101 rejection are respectfully requested.

4. Rejections under 35 U.S.C. § 103(a)

In the Action, Claims 1 through 5, 7 through 15, 17 through 21, and 25 are rejected under 35 U.S.C. § 103(a) as being unpatentable as obvious over United States Patent No. 5,877,954 to Klimasauskas, *et al.* (hereinafter "Klimasauskas") in view of United States Patent No. 5,477,444 to Bhat et al. (hereinafter "Bhat"). Applicants traverse the rejection by stating that commonly owned Klimasauskas, Bhat, and the combination thereof do not disclose or suggest all of the elements of Claim 1.

a. Discussion of KSR International Co. v. Teleflex, Inc., *et al.*

The U.S. Supreme Court's decision in *KSR International Co. v. Teleflex, Inc., et al.,* No. 04-1350, 550 U.S. _____ (2007) has issued since the mailing of the instant Office Action. In *KSR*, the Court rejected the Federal Circuit's rigid application of its teaching-suggestion-motivation test for obviousness. Slip Op. at 11. Instead, the obviousness test set forth in *Graham v. John Deere Co. of Kansas City,* 383 U.S. 1 (1966) is reaffirmed. Under 35 U.S.C. §103, the scope and content of the prior art are to be determined; differences between the prior

art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art is resolved. Using this analysis, non-obviousness of the Claims is determined. Secondary considerations, such as commercial success, long felt but unsolved needs, and failure of others may also be lodged by the Applicants to give light to the circumstances surrounding the origin of the subject matter sought to be patented once a *prima facie* case of obviousness is made. See *Graham*, 383 U.S. at 17-18. The Supreme Court held in *KSR* that "[t]he obviousness analysis cannot be confined by a formalistic conception of the words teaching, suggestion, and motivation, or by overemphasis on the importance of published articles and the explicit content of issued patents." See Slip Op. at 15.

"If a person of ordinary skill can implement a predictable variation, [35 U.S.C.] §103, likely bars patentability." See Slip Op. at 13. "[A] court must ask whether the improvement is more than the predictable use of prior art elements according to their established functions." See Slip Op. at 13. The Supreme Court has determined that "any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed." See Slip Op. at 16. The Supreme Court has stated that "[o]ne of the ways in which a patent's subject matter can be proved obvious is by noting that there existed at the time of invention[,] a known problem for which there was an obvious solution encompassed by the patent's claims." See Slip Op. at 16.

In light of the decision in *KSR*, Applicants state that Claims 1 through 5, 7 through 15, 17 through 21, and 25 are patentable over the cited references as the claimed invention is more than the predictable use of prior art elements according to their established functions. See Slip Op. at 13. In addition, there is no rational, articulated reasoning to combine the references, and the resulting combination, as purported by the Office, does not render Claim 1 obvious as the references do not disclose or suggest the elements of Claim 1, or provide any articulation of the known problem that the Applicants are solving. Moreover, these references disclose using neural networks, which operate very poorly and are unstable in regions of sparse or missing data, and for which the Applicants' method operates very advantageously over the art.

b. Discussion of Primary Reference

At page 8 of the Action, the Office states that Klimasauskas discloses, "creating an initial model generally corresponding to the non-linear empirical process to be modeled...(See Klimasauskas: col. 2, lines 27 through 31". The Office is incorrect. Klimasauskas does not create an initial model that generally corresponds to the non-linear empirical process to be modeled. Instead, Klimasauskas' model runs in parallel with a neural network model, which is a black box, and is unchanged. Klimasauskas' neural network cannot enforce global constraints because the minimum gain is always zero, and the derivative will not match or generally correspond to the shape that will occur in a complex non-linear empirical process. This is quite different from Claim 1, which is directed to creating an initial model that generally corresponds to the non-linear empirical process to be modeled. Klimasauskas uses a statistical model.

The Office further states that Klimasauskas discloses, "constructing a non-linear network model based on the initial model, [and] the non-linear network model having multiple inputs based on the initial input and a global behavior for the non-linear network model as a whole that conforms generally to the initial output [with] the global behavior being at least in regions of sparse initial input" at Column 2, lines 36 through 38, and 47 through 50, and at Column 8, lines 55 through 61. Again, Applicants respectfully disagree with the Office.

Klimasauskas discloses using a neural network for modeling a process. This is empirically based, and involves the training of data. The Office also cites a section, which discloses PLS models. These models are not non-linear models, but instead are linear models.

In fact, Klimasauskas agrees with the Applicants, and states at Column 2, lines 27 through 47, that "... neural network models have been criticized on the basis that 1. they are empirical; 2. they possess no physical basis; and 3. they produce results that are inconsistent with prior experience." Further, PLS models, generally, do not work well when dealing with a non-linear empirical process. In comparison, Applicants' method works well in non-linear processes, and with sparse data.

Klimasauskas discloses a linear model, and thus always will use a fixed linear model in areas of interpolation and extrapolation in order to protect against spurious behaviour of the neural network. It does not use an analytically constrained nonlinear network model, or

construct such an analytically constrained nonlinear model as claimed in Claim 1. Klimasauskas also does not construct based on the initial model, as claimed in Claim 1. First, as fully more discussed above, Klimasauskas does not create an initial model as claimed in Claim 1. Second, an initial model is not the basis in Klimasauskas for constructing a non-linear network model as claimed in Claim 1.

The Office at page 8 of the Action states that Klimasauskas discloses "calibrating the non-linear network model based on empirical inputs by using a bound on an analytical derivative of the base non linear function (See Klimasauskas: col. 12, lines 63-66, and col. 13, lines 6-9)".

Furthermore, Klimasauskas does not disclose or suggest calibrating the non-linear network model based on empirical inputs by using a bound on an analytical derivative of the base non-linear function. Klimasauskas also does not disclose or suggest a global behavior as a whole that conforms generally to the initial output. Klimasauskas discloses training the neural network. However, during training, Klimasauskas does not change the algorithm of the neural network, let alone use a bound on an analytical derivative of the base non-linear function as claimed.

To be present, a bound would result in producing an optimized model. This occurs by constraining the behavior of the non-linear network model while the model receives the input data to train the model to conform to the general I/O mapping specified in the initial model, and while being constrained by the constraints (e.g., by complementary pairing, by a bounded derivative of the non-linear transfer function, or other constraint approach).

In a preferred embodiment, the optimizer constrains the model output to be monotonically increasing based on the constraints as described in stage. In alternate embodiments, the optimizer constrains the model output by other criteria. See Applicants' page 16, line 29 through page 17, line 7.

The Office agrees at page 9 of the Action that Klimasauskas does not disclose global properties including a global minimum value and a global maximum value of the analytical derivatives to be calculated directly from model coefficients with the global properties being used to produce an analytically constrained model with global behavior enabling control of the non-linear process. For this limitation, the Office is looking to Bhat, which is misplaced, as discussed in the next section.

c. Discussion of Secondary, Bhat Reference

Bhat discloses a multivariable predictive controller that uses a neural network as a process model. It also has an additional unit where plant data is collected and another neural network is trained (in the background).

Then, by using either operator instruction (or automatically) the background neural net can replace the neural net within the controller (the target and path optimizer). This process can then repeat as more data is collected. This is the adaptive method of Bhat.

Bhat does not disclose or suggest calibrating a non-linear network model based on empirical inputs by using a bound on an analytical derivative of the base non-linear function that allows global properties including at least a global minimum value and a global maximum value of the analytical derivatives to be calculated directly from model coefficients. Additionally, Bhat does not disclose or suggest that the global properties are used to produce, by a constrained nonlinear optimization method, an analytically constrained model with global behavior, as claimed in Claim 1.

Bhat discloses treating regions of sparse data by collecting more and more data continuously. This creates an ever increasing sized data set. Bhat periodically retrains the neural network. No constraints on the neural network training method are disclosed, and the training simply forces the neural net prediction to fit the data.

Bhat does not disclose or suggest any analytical method for constraining the behavior of the model in regions of sparse data. Bhat simply collects more data which may or may not fill the sparse data regions. There are no analytical guarantees.

The Office relies on Column 9, lines 43 through 48 of Bhat to disclose (1) calibrating a non-linear network model by using a bound on an analytical derivative of the base non-linear function that allows global properties including at least a global minimum value and a global maximum value of the analytical derivatives to be calculated directly from model coefficients; and (2) that the global properties are used to produce, by a constrained nonlinear optimization method, an analytically constrained model with global behavior.

Applicants respectfully submit that the Office is incorrect. Column 9, lines 43 through 48 of Bhat has nothing to do with model calibration or training, and instead this passage refers to using a pre-trained neural network within a real-time optimizer to calculate an optimal set of set points to be downloaded to process plant equipment. This cited passage refers to a deployment stage, not a calibration stage, and is trivial since it does not constrain any model. One of ordinary skill in the art would not be able to modify Klimasauskas by reviewing Bhat to arrive at Claim 1. Bhat refers to a manner in which an optimizer deals with input/output constraints in a dynamic control environment, once the model has are already been trained.

For example, for safety reasons, there may be hard constraints on certain flows to a reactor (minimum of 0 and a maximum of say 15 t/hr). Bhat simply discloses respecting these hard constraints in deployment, when calculating set points from a controller, nothing more.

Other constraints may be soft constraints. An example of such a soft constraint may be product quality. For example, C4 composition should be 1.5 mole percent but 20% plus or minus above or below this amount can be tolerated. The controller optimizer of Bhat will then iterate to a solution of set point targets that respects all hard constraints and optimizes all soft constraints as close to their targets as possible. This is completely different relative to Claim 1.

None of these types of real-time process constraints in the deployment of the model are relevant to the "calibration stage" as claimed in Claim 1.

Bhat simply refers to how an optimizer mathematically deals with constraints that create discontinuous optimization surfaces. Bhat discloses avoiding a discontinuity by using a cubic spline to interpolate around these discontinuities so the optimizer does not fail when optimizing close to these constraints.

The Office cites to Column 9, lines 43 through 48 of Bhat, which is not relevant for the constrained nonlinear approximator of the present invention since Bhat describes a real time method for mathematically dealing with discontinuities in constraint surfaces during deployment.

Bhat does not teach or suggest methods of imposing analytical constraints on models as claimed in Claim 1. Bhat deals with input/output constraints, not model derivatives. Bhat does not affect the model in any way, and only uses the model for predictions of the process constraint surface. Column 9, lines 43 through 48 of Bhat in no way deals with the ability of the model to

predict reliably in regions of sparse data. Column 9, lines 43 through 48 of Bhat does not have any relevance to imposing analytical constraints on a model calibration algorithm.

Column 9, lines 43 through 48 of Bhat does not deal with optimizing using model coefficients. The constraints described by Bhat are real time input/output constraints during a deployment stage. These are completely different "optimal set point parameters" as compared with the constraints referenced in the present application which refer to constraints on model coefficients and model derivatives. Bhat makes no reference to any constraints on model gains.

Applicants contend that Klimasauskas, Bhat, and the combination thereof do not disclose or suggest calibrating the non-linear network model based on empirical inputs by using a bound on an analytical derivative of the base non-linear function that allows global properties such as the global minimum and maximum values of the analytical derivatives to be calculated directly from model coefficients that can be used to produce, via a constrained nonlinear optimization method, an analytically constrained model with global behavior.

Applicants believe that Claims 10, 11 and 21 are patentable for reasons similar to those argued above for Claim 1. Claims 2 through 5 and 7 through 9 depend from Claim 1, and Claims 12 through 15 and 17 through 20 depend from Claim 11. Thus, these claims are patentable for at least the reasons discussed above for the base claims from which they depend. As such, the 35 U.S.C § 103(a) rejections of Claims 1 through 5, 7 through 15 and 17 through 21 are believed to be overcome and should be withdrawn. Reconsideration and withdrawal of the rejection are earnestly solicited.

Applicants further contend that independent Claim 25 is also patentable for reasons similar to those argued above for Claim 1. Applicants submit that none of the references alone or in combination with one another disclose or suggest a method of constructing a non-linear network model based on the initial model with the non-linear network model having (a) multiple inputs based on the initial input and (b) a global behavior for the non-linear network model as a whole that conforms generally to the initial output with the global behavior being at least in regions of sparse initial input or in regions of missing initial input. Allowance of Claim 25 is requested.

5. **Newly added Claims 26 through 30**

Newly added Claim 26 is patentable over the cited references as the cited references do not disclose or suggest that the global properties including at least a global minimum value and a global maximum value of the analytical derivatives are calculated and manipulated directly from model coefficients. The cited references do not disclose or suggest manipulating the maximum and minimum directly from the model coefficients. A standard neural net cannot manipulate global model gains as claimed (*i.e.* the minimum absolute gain of a standard neural network is always zero), and thus the cited references teach away from Claim 26. Support for Claim 26 can be found at page 17, lines 8 through 17.

Newly added Claim 27 is also patentable over the cited and relied upon references as none of the references disclose or suggest that the model coefficients are manipulated by using a modified base non-linear function. Newly added Claim 28 is further patentable as the cited references do not disclose or suggest that the model coefficients are manipulated by using a modified base non-linear function that excludes at least one of a hyperbolic tangent function, a radial basis function, and a sigmoid function, with a base non-linear function having a global minimum or maximum first derivative that is independent of the model coefficients.

Newly added Claim 29 is patentable over the cited references as none of the references alone or in combination disclose or suggest the model coefficients are manipulated and that the global maximum and minimum values of the analytical derivatives are both a free function of the model coefficients. Claim 30 is patentable for at least the same reasons discussed above for Claim 29. Support for Claims 27 through 30 can be found in the patent application as originally filed at page 25, line 20 through page 26, line 3. No new matter is added.

6. **Newly added Claims 31 through 64**

For the purposes of full disclosure to the Office, Applicants' new Claims 31 through 59 are added to the patent application, and were copied from Claims 31 through 59 of United States Patent Application Serial No. 10/842,157 to Sayyar-Rodsari. As mentioned, these copied claims

have not issued, or been allowed, or examined. The subject application is currently being examined by Examiner Gami Tejal of the Office in Group Art Unit No. 2121 of Class/Subclass 700/029. Applicants note that Sayyar-Rodsari's Claims 31 through 59 were added by an Amendment dated April 9, 2007. Applicants state that the Sayyar-Rodsari Amendment is publicly available using the United States Patent Office PAIR retrieval system.

Applicants contend that Sayyar-Rodsari's Claims 31 through 59 are fully supported by the Applicants' specification as originally filed. In addition, Applicants have added new Claims 60 through 64, which are directed to the same or substantially the same subject matter as independent Claims 31, 50, 55, 56, and 64 of the Sayyar-Rodsari patent application.

Applicants' Independent Claim 31 and 60

Applicants' Claim 31 recites a computer accessible memory medium that stores program instructions for model predictive control and optimization of a nonlinear process, wherein the program instructions are executable by a processor. Support for this limitation can be found in Applicants' patent application as originally filed at page 17, lines 21 through 30, which state that a controller 26 may receive empirical data input 30 from sensors that monitor the inputs and states of different aspects of the industrial process.

Claim 31 also provides for a parametric universal nonlinear dynamic approximator for predictive optimization or control of a nonlinear process that comprises a parameterized dynamic model operable to model the nonlinear process and wherein the parameterized dynamic model comprises one or more parameters that are not inputs or outputs of the nonlinear process. Support for this limitation can be found in Applicants' patent application as originally filed at page 5, lines 14 through 15, at page 14, line 23 through page 15, line 18, at page 19, line 6 through 16, and at page 33, line 26 though page 34, line 6.

Applicants disclose a state space model, at page 33, line 26 though page 34, line 6 which is a parametric model. Applicants disclose that the model can be dynamic at page 5, lines 14 through 15, and that the model can be constrained on-line in an adaptive manner at page 19, lines 6 through 16 of the Applicants' patent application as originally filed. Applicants disclose (at page 33, lines 19 through page 34, line 6) parameters that are not inputs or outputs of the

process. Applicants also disclose a non-linear approximator operable to model dependencies of the one or more parameters of the parameterized dynamic model upon operating conditions of the nonlinear process at page 18, line 10 through line 13, at page 12, line 9 through page 13, line 26, at page 19, line 6 through line 16, and at page 33, line 26 through page 34, line 6 of the Applicants' patent application as originally filed. No new matter is added.

Applicants disclose that the parametric universal nonlinear dynamic approximator is operable to predict process outputs necessary for predictive control and optimization of the nonlinear process at page 10, line 14 through line 24, at page 17, line 21 through page 18, line 9, and at page 18, line 10 through line 13 of the Applicants' patent application as originally filed. No new matter is added.

Applicants further disclose that the nonlinear approximator is operated to receive one or more process operating conditions, including one or more process inputs at page 17, lines 21 through line 30, and at page 33, line 26 through page 34, line 9, and in FIG. 1 of the patent application as originally filed. Applicants disclose that the values are generated for the one or more parameters of the parameterized dynamic model based on process operating conditions. Applicants disclose operating the parameterized dynamic model to receive the values of the one or more parameters, receiving the one or more process inputs, and generating one or more predicted process inputs based on the received one or more parameters and the received one or more process inputs. Applicants further disclose storing the one or more predicted process outputs. Support for these limitations can be found at page 17, line 21 through page 17, line 30, at page 18, line 6 through line 9, at page 18, line 22 through page 19, line 16, and at page 33, line 26 through page 34, line 6 of the Applicants' patent application as originally filed. Claim 60 is supported in a similar manner referenced above. No new matter is added.

<u>Applicants' Claim 32</u>

Support for dependent Claim 32 can be found in the Applicants' patent application as originally filed at page 6, lines 10 through 28, at page 5, line 3 through line 13, and at page 33, line 26 through page 34, line 6 of the patent application as originally filed. No new matter is added.

Applicants' Claim 33

Support for dependent Claim 33, which recites that the nonlinear approximator and the parameterized dynamic model are operable to be trained in an integrated manner by an optimization process are supported at page 18, lines 10 through 13, and at page 33, line 26 through page 34, line 6 of the Applicants' patent application as originally filed. No new matter is added.

Applicants' Claim 34

Claim 34 recites that the parametric dynamic approximator is operable to be coupled to the nonlinear process or a representation of the nonlinear process and the nonlinear process is operable to receive the one or more process inputs and produce the one or more process outputs. Claim 34 further recites that the optimization process is operable to determine model errors based on the one or more process outputs and the one or more predicted process outputs, and the optimization process is operable to adaptively train the parametric universal nonlinear dynamic approximator in an iterative manner using the model errors and an optimizer. Support for Claim 34 can be found at page 17, line 21 through 30, at FIG. 1, at page 17, line 18 through 20, at page 6, line 10 through 28, at page 33, line 26 through page 34, line 6, at page 17, lines 8 through 17, at page 19, lines 6 through 16, and at page 2, lines 5 through 17 of the Applicants' patent application as originally filed. No new matter is added.

Applicants' Claim 35

Claim 35 recites that in training the parametric universal nonlinear dynamic approximator in an iterative manner using model errors and the optimizer with the optimization process is operable to identify process inputs and outputs (I/O), which is disclosed at page 17, line 8-17, at page 18, lines 10 through 14, at page 33, line 26 through page 34, line 6, at page 16, line 11

through line 28 of the Applicants' patent application as originally filed. Claim 35 also recites that the process is operable to determine an order of the model and the order specifies a number of parameters in the model, which is disclosed at page 33, line 26 through page 34, line 6, and at page 18, line 10 through line 13 of the Applicants' patent application as originally filed. Claim 35 also recites that the process collects data, and determines constraints on behavior of the approximator. This is from prior knowledge including one or more constraints for the non-linear approximator for modeling dependencies of the one or more parameters of the model. This is disclosed at page 6, lines 3 through 9, and at page 17, line 21 through line 30 of the Applicants' patent application as originally filed.

Claim 35 further recites that the process is operable to formulate an optimization problem, which is disclosed at page 16, line 11 through line 28 of the Applicants' patent application as originally filed. Claim 35 still further recites that that process executes an optimization algorithm to determine the dependencies of the parameters upon operating conditions of the non-linear process subject to the constraints by solving the optimization problem thereby training the non-linear approximator. Support can be found in the Applicants' patent application as originally filed at page 5, lines 14 through 18, and at page 18, line 14 through page 19, line 5.

Claim 35 further recites that the process verifies compliance of the approximator with the constraints. Support can be found for this limitation at page 17, lines 8 through 17, and at page 33, line 25 through page 34, line 6. No new matter is added.

Applicants' Claim 36

Claim 36 recites that in verifying compliance the process is operable to use interval arithmetic over the global input region or to use interval arithmetic with input region partitioning. Support for Claim 36 can be found at page 33, line 19 through page 34, line 6, at page 17, line 8 through line 17, and at page 6, line 29 through page 7, line 2 of the Applicants' patent application as originally filed. No new matter is added.

Applicants' Claim 37

Claim 37 recites that in determining the order of the model the optimization process is operable to execute the optimization algorithm to determine an optimal order of the parameterized dynamic model. Support for Claim 37 can be found at page 33, line 26 through page 34, line 6, and at page 18, line 10 through line 13 of the patent application as originally filed. No new matter is added.

Applicants' Claim 38

Claim 38 recites that the order of the model is determined and the nonlinear approximator is trained concurrently. Support for Claim 38 can be found at page 33, line 26 through page 34, line 6, and at page 18, lines 10 through 13 of the patent application as originally filed. No new matter is added.

Applicants' Claim 39

Claim 39 recites that in formulating the problem that the process is operable to modify or determine an objective function. Support for Claim 39 can be found at page 17, line 8 through line 17 of the patent application as originally filed. No new matter is added.

Applicants' Claim 40

Claim 40 recites that in solving the problem that the process is operable to solve the objective function subject to the constraints. Support for Claim 40 can be found at page 17, line 8 through line 17 of the patent application as originally filed. No new matter is added.

Applicants' Claim 41

Claim 41 recites that after being trained the overall behavior of the parametric universal nonlinear approximator is consistent with prior knowledge of the non-linear process. Support for Claim 41 can be found at page 6, line 3 through line 9. No new matter is added.

Applicants' Claim 42

Claim 42 recites that the nonlinear approximator comprises one or more of a neural network, a support vector machine, a statistical model, a parametric description of the nonlinear process, a Fourier series model, or an empirical model. Support for Claim 42 can be found at least at page 5, line 3 through line 13 of the patent application as originally filed. No new matter is added.

Applicants' Claim 43

Claim 43 recites that the nonlinear approximator comprises a universal nonlinear approximator. Claim 43 is supported at least at page 5, line 3 through line 13, and at page 15, lines 19 through 26. No new matter is added.

Applicants' Claim 44

Claim 44 discloses that the approximator includes a feedback loop that is operable to provide the output of the approximator from a previous cycle as input to the approximator for a current cycle. Support for Claim 44 can be found at page 33, line 26 through page 34, line 6 of the patent application as originally filed. No new matter is added.

Applicants' Claim 45

Claim 45 recites that the model comprises a multi-input, multi-output (MIMO) dynamic model implemented with a set of difference equations. Support for Claim 45 can be found in the patent application as originally filed at page 33, line 26 through page 34, line 6. No new matter is added.

Applicants' Claim 46

Claim 46 recites that the set of difference equations comprises a set of discrete time polynomials. Support for Claim 46 can be found in the patent application as originally filed at page 33, line 26 through page 34, line 6, and at page 32, line 12-20. No new matter is added.

Applicants' Claim 47

Claim 47 discloses that the process inputs are received from the non-linear process or a representation of the non-linear process. Support for Claim 47 can be found in the patent application as originally filed at page 26, line 27 through page 27, line 7, at page 32, line 12 through line 20, and at page 17, lines 18 through 30. No new matter is added.

Applicants' Claim 48

Claim 48 recites that the representation comprises one or more of a statistical model, a first principles model, a parametric description of the non-linear process, a Fourier series model, an empirical model, or empirical data. Support for Claim 38 can be found at page 17, lines 18 through 30. No new matter is added.

Applicants' Claim 49

Claim 49 recites that the parametric universal nonlinear approximator is operable to be coupled to the process, and further to a control process. The control process is operable to initialize the approximator to a current status of the process that has process inputs and process outputs by initializing inputs to a nonlinear approximator. The approximator is trained to model dependencies of one or more parameters upon an operating condition of the process, and executes the trained approximator to determine initial values based on the current status of the nonlinear process. The model is initialized with the determined values.

An optimization problem is formulated including specifying an objective to the nonlinear process, and a profile of manipulated variables is generated over a control horizon in accordance with a specified objective. The approximator is operated in accordance with the profile, and a deviation of the outputs from a desired behavior is determined. An optimal profile in accordance with the objective is determined, and the nonlinear process operates in accordance with the optimal profile. The non-linear process is then dynamically controlled. Claim 49 is supported at page 9, line 29 through page 10, line 14, at page 17, line 18 through line 30, at page 33, line 26 through page 34, line 6, at page 19, lines 6 through 16, at page 18, lines 10 through 13, and at page 17, lines 21 through 30. No new matter is added.

Applicants' Claim 50, and 61

Claim 50 discloses a method for training a parametric universal dynamic nonlinear approximator of a nonlinear process that comprises identifying process inputs, and outputs, and determining an order for a model where the order specifies the number of parameters of the model, and the parameters are not inputs or outputs. Claim 50 also recites determining a structure for a non-linear approximator for modeling dependencies of the parameters upon operating conditions of the nonlinear process.

The method collects data for the identified process I/O and determines constraints on the behavior of the approximator from prior knowledge including one or more constraints for the

nonlinear approximator for modeling dependencies of the one or more parameters of the model. The method formulates an optimization problem, and executes an optimization algorithm to train the approximator to determine dependencies of the parameters upon operating conditions of the process, and verifies compliance with the constraints. The method further stores the approximator and the model to compose a trained approximator that is usable to optimize and control the nonlinear process.

Support for Claim 50 can be found at page 33, line 26 through page 34, line 6, at page 18, line 10 through line 13, at page 16, line 11 through line 28, at page 19, lines 6 through 16, at page 17, lines 21-30, at page 6, lines 10 through 28, at page 6, lines 3-9, at page 17, lines 8 through 17, at page 34, line 27 through page 35, line 4, at page 5, lines 3 through 13, at page 18, lines 14 through 17, and at page 16, line 29 through page 17, line 7. No new matter is added. Claim 61 is supported in a similar manner to independent Claim 50.

Applicants' Claim 51

Support for Claim 51 can be found at page 5, lines 3 through 13, at page 34, line 27 through page 35, line 5, at page 33, line 26 through page 34, line 6, and at page 6, line 29 through page 7, line 2 of the patent application as originally filed. No new matter is added.

Applicants' Claim 52

Support for Claim 52 can be found at page 18, lines 10 through 13, and at page 34, line 27 through page 35, line 5 of the patent application as originally filed. No new matter is added.

Applicants' Claim 53

Support for Claim 53 can be found at page 18, lines 10 through 13, and at page 34, line 27 through page 35, line 5 of the patent application as originally filed. No new matter is added.

Applicants' Claim 54

Support for Claim 54 can be found at page 17, lines 8 through 17 of the patent application as originally filed. No new matter is added.

Applicants' Claims 55 and 62

Support for Claim 55 can be found in the patent application as originally filed at page 5, lines 3 through 13, at page 34, line 27 through page 35, line 4, at page 33, line 26 through page 34, line 6, at page 16, lines 11 through 28, at page 18, lines 10-17, at page 14, line 23 through page 15, line 18, at page 19, lines 24 through 28, at page 29, lines 17 through 23, at page 6, lines 3 through 28, page 17, lines 8 through 17, at page 34, line 22, and 23, at equations 21 and 22, at page 21, line 15 through page 35, line 25, at page 9, line 29 through page 10, line 13, at page 19, line 6 through 16, at page 19, line 24 through line 28, at page 29, lines 17-23, at page 5, lines 25 through page 6, line 2, and at page 17, lines 21 through 30. No new matter is added. Claim 62 is supported in a similar manner to Claim 55.

Applicants' Claims 56 and 63

Support for Claim 56 can be find in the patent application as originally filed at page 17, lines 21 through 30, at page 33, line 26 through page 34, line 6, at page 18, line 10 through line 13, at page 14, line 22 through page 15, line 18, at page 19, line 24 through 28, at page 29, lines 17 through 23, at page 5, lines 3 through 13, and at page 17, lines 21 through 30. No new matter is added. Claim 63 is supported in a similar manner to Claim 56.

Applicants' Claim 57

Support for Claim 57 can found in the patent application as originally filed at page 19, lines 6 through 16, at page 18, lines 10 through 13, at page 17, lines 21 through 30, and at page 33, lines 26 through page 34, line 6. No new matter is added.

Applicants' Claim 58

Claim 58 is supported in the patent application as originally filed at page 19, lines 6 through 16, at page 17, lines 8 through 17, at page 33, line 26 through page 34, line 6, and at page 17, lines 21 through 30. No new matter is added by the addition of Claim 58.

Applicants' Claims 59 and 64

Support for Claim 59 can be found in the patent application as originally filed at page 17, lines 21 through 30, at page 10, lines 14 through 25, at page 33, line 26 through page 34, line 6, at page 18, lines 10 through 13, at page 5, lines 3 through 13, at page 14, line 23 through page 15, line 18, at page 33, lines 19 through 25, at page 61, lines 3 through 9, at page 18, lines 10 through 13, at page 5, lines 3 through 13, and at page 17, lines 21 through 30. No new matter is added. New Claim 64 is supported in a similar manner to Claim 59.

7. Republication of the Subject Patent Application

Applicants note that in the corresponding United States Published Patent Application No. US 2002/0072828 A1 to Turner *et al.,* several new claims are not listed and thus not published for the instant patent application, as these claims were added after the date of publication, or June 13, 2002.

Applicants herein submit a request to voluntarily republish the application with the correct claims under 37 C.F.R. § 1.221(a) with a fee. Contemporaneous with the instant

Amendment, Applicants herein submit a request for republication. The request includes a copy of the application, processing fee under 37 C.F.R. § 1.17(i) and publication fee under 37 C.F.R. § 1.18(d). Applicants again state that the voluntary republication should include Claims 1 through 64. Republication of the instant application with the correct claims is earnestly solicited.

CONCLUSION

In view of the above amendments and remarks, it is believed that all claims (Claims 1 through 64) are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned.

Respectfully submitted,

HAMILTON, BROOK, SMITH & REYNOLDS, P.C.

Jean-Paul Case #46,605 for

By Mary Lou Wakimura

Mary Lou Wakimura
Registration No. 31,804
Telephone: (978) 341-0036
Facsimile: (978) 341-0136

Concord, MA 01742-9133
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